

Xerox Special Information Systems

Xerox Special Information Systems (XSIS) is specially organized to meet the needs of customers who require uniquely designed, engineered, and integrated information, printing, and publishing systems not available through normal commercial channels.

XSIS is chartered to:

- Respond to Federal and commercial customer needs for non-standard information, printing, and publishing systems employing a high mix of Xerox standard products
- Work with other Xerox organizations to meet customer requirements for information, printing, and publishing systems
- Conduct development activities in relevant leading edge technologies

Located in manufacturing and office facilities exceeding 200,000 square feet in Pasadena, California, XSIS is involved in a wide range of programs encompassing such diverse fields as:

- Automated Message Centers
- Scanning, Storing, and Retrieval Systems
- Color Image Processing and Printing Systems
- Computer-Based Publishing and Demand Printing Systems
- Militarized Graphic Plotters
- Security Systems for Currency and Document Protection
- Classified Intelligence Applications

Dear Smalltalk-80 Customer,

Thank you for inquiring about our Smalltalk-80 software product line.

If you would like to purchase any of these products for delivery in the United States or Canada*, please fill out and sign the enclosed green *Software Order Form* and, if applicable, the yellow *Software License Terms and Conditions*.

The *Software License Terms and Conditions* is required for the following packages: ST80 DV6 for the Xerox 8010/1108 Series and Xerox 6085/1186 Series Workstations. We cannot ship ST80 DV6 without the completed original copy of this agreement.

A *Shrink Wrap* type of software license is used for the following Smalltalk-80 application packages: ANALYST, ASSISTANT, ASP, and HUMBLE. This agreement is attached to the outside of the boxes in which these packages are shipped. Enclosed is a copy for your review.

Please return the completed and signed green *Software Order Form*, the completed and signed yellow *Software License Terms and Conditions* (if applicable), and your *Purchase Order* or *Check* to:

Xerox Special Information Systems
250 North Halstead Street
P.O. Box 5608
Pasadena, CA 91107-0608

Attention: Smalltalk-80 Orders, MS 520

Commercial Smalltalk-80 systems are currently available from the following vendors:

| Vendor | Phone | Mailing Address | Smalltalk-80 Versions |
|-------------------|--------------|------------------------------------|--|
| APDA | 206-251-6548 | 290 SW 43rd St., Renton, WA 98055 | Apple Macintosh Series |
| ParcPlace Systems | 415-859-1000 | 2400 Geng Rd., Palo Alto, CA 94303 | Apple Macintosh Series Sun-2, -3, & -4 Series Apollo DOMAIN Series HP 9000 Series 300 |
| Tektronix, Inc. | 800-547-1512 | PO Box 1000, Wilsonville, OR 97070 | Tektronix 4400 Series Tektronix 4310 Series |
| XSIS | 818-351-2351 | PO Box 5608, Pasadena, CA 91107 | Xerox 8010/1108 Series Xerox 6085/1186 Series |

*Information on obtaining XSIS Smalltalk-80 products outside the United States and Canada is available on request.

If you have any questions or require additional information, please contact me at the address below. Thank you for your interest.

Very truly yours,



Evelyn Van Orden
Smalltalk-80 Products Manager

Prices effective June 1, 1988. Prices and availability are subject to change.

XEROX® and the Xerox product names identified herein are trademarks of Xerox Corporation.

Xerox Special Information Systems, P.O. Box 5608, Pasadena, CA 91107-0608 (818) 351-2351

6/88

Smalltalk-80 Software Packages US and Canada Prices in \$US^a

| PACKAGE | XSIS Part Number | SMALLTALK-80 SYSTEM | Per System License ^b | Support Per Hour ^c |
|-----------------------------|------------------------|--|---------------------------------------|-------------------------------------|
| ANALYST V2.1 | 3104042 | Mac II, ParcPlace Systems VI 2.2 DE | \$1095 | \$100 |
| | 3104043 | Sun-2/-3, ParcPlace Systems VI 2.2 DE | \$1995 | \$100 |
| | 3104044 | Tektronix 4405/4406 LOS (tape) | \$1995 | \$100 |
| | 3104045 | Xerox 8010/1108/1109, ST80 DV6 | \$1995 | \$100 |
| | 3104046 | Xerox 6085/1186, ST80 DV6 | \$1995 | \$100 |
| | 3104041 | ANALYST V2.1 Users Guide only | \$150 | N/A |
| | 3104115 | ANALYST Programmers Guide only | \$35 | N/A |
| ASSISTANT V1.0 ^d | 3104110 | Mac II, ParcPlace Systems VI 2.2 DE | \$495 | \$100 |
| | 3104111 | Sun-2/-3, ParcPlace Systems VI 2.2 DE | \$495 | \$100 |
| | 3104112 | Tektronix 4405/4406 LOS (tape) | \$495 | \$100 |
| | 3104113 | Xerox 8010/1108/1109, ST80 DV6 | \$495 | \$100 |
| | 3104114 | Xerox 6085/1186, ST80 DV6 | \$495 | \$100 |
| ASP V1.2 ^e | 3104003 | Softsmarts Smalltalk AT | \$495 | \$100 |
| | 3104004 | Mac + /SE/II, ParcPlace Systems VI 2.2 | \$495 | \$100 |
| | 3104005 | Sun-2/-3, ParcPlace Systems VI 2.2 | \$995 | \$100 |
| | 3104006 | Tektronix 4404 SOS (floppies) | \$995 | \$100 |
| | 3104007 | Tektronix 4405/4406 LOS (floppies) | \$995 | \$100 |
| | 3104008 | Xerox 8010/1108/1109, ST80 DV6 | \$995 | \$100 |
| | 3104009 | Xerox 6085/1186, ST80 DV6 | \$995 | \$100 |
| | 3104002 | ASP V1.2 Users Guide only | \$35 | N/A |
| HUMBLE V2.0 | 3104026 | Softsmarts Smalltalk AT | \$395 | \$100 |
| | 3104027 | Mac + /SE, Apple Smalltalk v.0.4 | \$395 | \$100 |
| | 3104028 | Mac + /SE/II, ParcPlace Systems VI 2.2 | \$395 | \$100 |
| | 3104029 | Sun-2/-3, ParcPlace Systems VI 2.2 | \$995 | \$100 |
| | 3104030 | Tektronix 4404/4405/4406 (floppies) | \$995 | \$100 |
| | 3104031 | Xerox 8010/1108/1109, ST80 DV6 | \$995 | \$100 |
| | 3104032 | Xerox 6085/1186, ST80 DV6 | \$995 | \$100 |
| | 3104024 | HUMBLE V2.0 Users Guide only | \$35 | N/A |
| ST80 DV6 | 3104060 | Xerox ST80 DV6 for 8010/1108/1109 | \$1995 | \$100 |
| | 3104061 | Xerox ST80 DV6 for 6085/1186 | \$1995 | \$100 |
| ST80 DE ^f | 3104089 | ParcPlace Systems VI 2.2 DE for Mac + /SE/II | \$1295 | \$100 |
| | 3104090 | ParcPlace Systems VI 2.2 DE for Sun-2/-3 | \$3995 | \$100 |

^a US and Canada Prices apply to packages purchased in and shipped within the United States and Canada only. Contact XSIS for availability of these products in other countries.

^b Per System License includes one user installable software installation kit for the designated type of Smalltalk-80 system (streaming tape or floppy disks), installation instructions, and one set of user documentation.

^c Support Per Hour is for additional support beyond the first hour. One hour of free phone support is provided to Registered Customers who return the *Smalltalk-80 Customer Registration Card* that is enclosed in each kit.

^d ASSISTANT V1.0 requires ANALYST V2.1 because it is designed as an add-on application for ANALYST V2.1.

^e ASP V1.2 is the same spreadsheet package that is integrated with ANALYST V2.1.

^f ParcPlace Systems Smalltalk-80 DE VI 2.2 for the Mac II and Sun-2/-3 are only available from XSIS if purchased with one of the other XSIS Smalltalk-80 Software Packages listed above.

**Quantity Discounts, Educational, Dealer, and VAR prices and terms
will be quoted upon request.**

Prices effective June 1, 1988. Prices and availability are subject to change.

XEROX® and the Xerox product names identified herein are trademarks of Xerox Corporation.

Xerox Special Information Systems, P.O. Box 5608, Pasadena, CA 91107-0608 Phone: (818) 351-2351

Software Order Form (US and Canada)

PO No. _____

Resale No. _____

Name _____

Organization _____

Ship-To _____ Bill-To _____

Phone () _____ Phone () _____

| PACKAGE | PART NO. | SMALLTALK-80 SYSTEM | EACH | QUANTITY | TOTAL (\$US) |
|---|----------|--|--------|----------|--------------|
| ANALYST V2.1 | 3104042 | Mac II, ParcPlace Systems VI 2.2 DE | \$1095 | _____ | \$ _____ |
| | 3104043 | Sun-2/-3, ParcPlace Systems VI 2.2 DE | \$1995 | _____ | \$ _____ |
| | 3104044 | Tektronix 4405/4406 LOS (tape) | \$1995 | _____ | \$ _____ |
| | 3104045 | Xerox 8010/1108/1109, ST80 DV6 | \$1995 | _____ | \$ _____ |
| | 3104046 | Xerox 6085/1186, ST80 DV6 | \$1995 | _____ | \$ _____ |
| | 3104041 | ANALYST V2.1 Users Guide only | \$150 | _____ | \$ _____ |
| | 3104115 | ANALYST Programmers Guide only | \$35 | _____ | \$ _____ |
| ASSISTANT V1.0 ^a | 3104110 | Mac II, ParcPlace Systems VI 2.2 DE | \$495 | _____ | \$ _____ |
| | 3104111 | Sun-2/-3, ParcPlace Systems VI 2.2 DE | \$495 | _____ | \$ _____ |
| | 3104112 | Tektronix 4405/4406 LOS (tape) | \$495 | _____ | \$ _____ |
| | 3104113 | Xerox 8010/1108/1109, ST80 DV6 | \$495 | _____ | \$ _____ |
| | 3104114 | Xerox 6085/1186, ST80 DV6 | \$495 | _____ | \$ _____ |
| ASP V1.2 ^b | 3104003 | Softsmarts Smalltalk AT | \$495 | _____ | \$ _____ |
| | 3104004 | Mac + /SE/II, ParcPlace Systems VI 2.2 | \$495 | _____ | \$ _____ |
| | 3104005 | Sun-2/-3, ParcPlace Systems VI 2.2 | \$995 | _____ | \$ _____ |
| | 3104006 | Tektronix 4404 SOS (floppies) | \$995 | _____ | \$ _____ |
| | 3104007 | Tektronix 4405/4406 LOS (floppies) | \$995 | _____ | \$ _____ |
| | 3104008 | Xerox 8010/1108/1109, ST80 DV6 | \$995 | _____ | \$ _____ |
| | 3104009 | Xerox 6085/1186, ST80 DV6 | \$995 | _____ | \$ _____ |
| | 3104002 | ASP V1.2 Users Guide only | \$35 | _____ | \$ _____ |
| HUMBLE V2.0 | 3104026 | Softsmarts Smalltalk AT | \$395 | _____ | \$ _____ |
| | 3104027 | Mac + /SE, Apple Smalltalk v.0.4 | \$395 | _____ | \$ _____ |
| | 3104028 | Mac + /SE/II, ParcPlace Systems VI 2.2 | \$395 | _____ | \$ _____ |
| | 3104029 | Sun-2/-3, ParcPlace Systems VI 2.2 | \$995 | _____ | \$ _____ |
| | 3104030 | Tektronix 4404/4405/4406 (floppies) | \$995 | _____ | \$ _____ |
| | 3104031 | Xerox 8010/1108/1109, ST80 DV6 | \$995 | _____ | \$ _____ |
| | 3104032 | Xerox 6085/1186, ST80 DV6 | \$995 | _____ | \$ _____ |
| | 3104024 | HUMBLE V2.0 Users Guide only | \$35 | _____ | \$ _____ |
| ST80 DV6 ^c | 3104060 | Xerox ST80 DV6 for 8010/1108/1109 | \$1995 | _____ | \$ _____ |
| | 3104061 | Xerox ST80 DV6 for 6085/1186 | \$1995 | _____ | \$ _____ |
| ST80 DE ^d | 3104089 | ParcPlace Systems VI 2.2 DE for Mac + /SE/II | \$1295 | _____ | \$ _____ |
| | 3104090 | ParcPlace Systems VI 2.2 DE for Sun-2/-3 | \$3995 | _____ | \$ _____ |
| Shipping and handling for each item above | | | \$10 | _____ | \$ _____ |
| Subtotal | | | | | \$ _____ |
| Sales tax for your area | | | % | | \$ _____ |
| CANADA ONLY: Export handling charge | | | \$25 | | \$ _____ |
| TOTAL AMOUNT DUE | | | | | \$ _____ |

^a ASSISTANT V1.0 requires ANALYST V2.1 to be used.^b ASP V1.2 is the same spreadsheet package that is integrated with all versions of ANALYST V2.1.^c ST80 DV6 orders must include a signed original Xerox Software License Terms and Conditions.^d ParcPlace Systems ST80 DE is only available from XSIS if ordered with one or more XSIS ST80 software packages.

Signature _____ Date _____

Prices effective June 1, 1988. Prices and availability are subject to change.

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Smalltalk-80 Software Packages Configuration Requirements

ANALYST V2.1

ANALYST V2.1 is delivered as a Smalltalk-80 image with full source code. Workstation configuration and Smalltalk-80 system requirements for the different versions are:

| | |
|-------------------|--|
| Macintosh II: | 5 MB or more of main memory 7.5 MB or more of free disk storage* ParcPlace Systems Smalltalk-80 DE VI2.2/VM1.1 for Mac II |
| Sun-2 or Sun-3: | 6 MB or more of main memory 7.5 MB or more of free disk storage* ParcPlace Systems Smalltalk-80 DE VI2.2/VM1.1 for Sun-2/-3 |
| Tektronix 4405/6: | 4 MB or more of main memory 7.5 MB or more of free disk storage* Tektronix Smalltalk-80 Large Object System T2.2.0C |
| Xerox 8010/1108: | 3.5 MB of main memory, 12K control store 7 MB (14,000 pages) or more of free disk storage* Xerox 1108 Smalltalk-80 DV6 System (refer to next page) |
| Xerox 6085/1186: | 3.7 MB of main memory, 8K control store 7 MB (14,000 pages) or more of free disk storage* Xerox 1186 Smalltalk-80 DV6 System (refer to next page) |

*Disk storage requirements listed above are for the files delivered with ANALYST. Additional disk storage is required for the Smalltalk-80 system and for user file space.

ASP V1.2

The ASP Analytic Spreadsheet Package is similar to the package integrated with ANALYST. It is available to customers who do not require the entire ANALYST system, or who have insufficient workstation resources to support ANALYST.

ASP V1.2 is delivered as a set of source code file-ins. It requires a minimum of 500 KB of object space after the Smalltalk-80 image is loaded. It requires about 500 KB of free disk storage.

HUMBLE V2.0

HUMBLE V2.0 is delivered as a set of source code file-ins. It requires a minimum of 200 KB of object space after the Smalltalk-80 image is loaded. It requires about 400 KB of free disk storage.

NOTE: The Apple Smalltalk v.0.4 system that is currently available from the Apple Programmers and Developers Association (APDA) is not fully compatible with the Mac II. Therefore, HUMBLE V2.0 is only recommended for Apple Smalltalk v.0.4 on the Mac Plus and SE. If you wish to run HUMBLE V2.0 on a Mac II, please obtain the ParcPlace Systems VI2.2/VM1.1 System.

Smalltalk-80 Software Packages Configuration Requirements (cont.)

SMALLTALK-80 DV6

SMALLTALK-80 DV6 (ST80 DV6) is available for the following Xerox professional workstation configurations:

Xerox 1108 AI Workstation

The Xerox 1108 AI Workstation is a high end configuration of the Xerox 8010 Professional Workstation.

The 1108-1115 is the model required for the Smalltalk-80 system:

| | |
|--------------------|---|
| Main Memory: | 3.5 MB |
| Control Store: | 12K with Weitek 1032 & 1033 Floating Point Chips* |
| Rigid Disk Drive: | 42 MB or 80 MB (or larger) |
| Floppy Disk Drive: | One 8" |
| Display: | 17", 1024 X 808 Pixels, Old-Style or New Style |
| Keyboard: | Old-Style or New-Style |
| Mouse: | 3-Button Recommended, 2-Button OK |

*The newer Weitek 1232 & 1233 chips are not supported.

Xerox 6085 Smalltalk Workstation

The Xerox 6085 Smalltalk Workstation is a high end configuration of the Xerox 6085 Personal Workstation.

The 6085S is the model required for the Smalltalk-80 system:

| | |
|--------------------|-----------------------------------|
| Main Memory: | 3.7 MB |
| Control Store: | 8K |
| Rigid Disk Drive: | 40 MB or 80 MB (or larger) |
| Floppy Disk Drive: | One or More 5.25" |
| Display: | 19", 1152 X 862 Pixels |
| Keyboard: | ViewPoint Keycaps Recommended |
| Mouse: | 3-Button Recommended, 2-Button OK |

ST80 DV6 currently runs in the Xerox Development Environment (XDE) Version 5.0 (Tajo/Pilot/Mesa version 12.3). It resides on the Tajo volume and occupies about 4 MB (8,000 pages) of disk space. It replaces the standard Mesa initial microcode and Pilot microcode with versions that support the Smalltalk-80 system. This ST80/XDE microcode is fully compatible with XDE 5.0 and ViewPoint 1.1, but it is not compatible with Interlisp-D.

ST80 DV6 installation procedures currently assume that the workstation will be dedicated to the use of Smalltalk-80 only.

The Analyst Workstation System



An integrated information analysis environment

The Analyst™ Workstation System is an integrated set of special application packages implemented in the Xerox Smalltalk-80™ environment that provides a wide range of information analysis capabilities. These packages are used by professional analysts as tools in a working environment that can be customized to individual needs, as well as by programmers as a foundation for the development of sophisticated interactive applications.

The Analyst is derived from a series of integrated analyst software packages developed in the Smalltalk-80 environment during the past 6 years at Xerox Special Information Systems (X SIS). It is designed to fulfill requirements for an intelligent, interactive, graphics-oriented environment for manipulating text, graphics, maps, and image data.

The Analyst is commercially available in the form of commented Smalltalk-80 source code that can be integrated into any Smalltalk-80 system.

The Analyst Information Center

At the hub of The Analyst is the Information Center, an integrated information management system that organizes all resources and tools for both novice and experienced users. Reports consisting of formatted text, spreadsheets, charts, graphs, maps, and illustrations are easily created, printed, and stored with the Information Center.

Data Security. Windows reflect the highest security level of all information contained within them. The Analyst helps insure that any organization's data remains where it should.

Maps and Images. The Analyst displays, zooms, and annotates scanned images and maps. Maps are generated on demand from an optional map database.

Business Graphics. Pie, bar, line charts, clustered or stacked bar charts, and x-y scatter or linear fit plots can be generated. Charts can be created interactively or automatically from data stored in personal databases.

Personal Databases. Personal databases with fixed-length fields and records can be created and updated. These databases can store a wide variety of information, including textual and numeric data, geographic data for display on maps, temporal data for animation, and business or technical data for charting. A powerful user interface allows sorting, report generation, and queries without knowledge of the query language. The user can link records to more

extensive data sets in any information center. Complete record-by-record data security information is also retained.

The Analyst Spreadsheets. Spreadsheets can be created with an arbitrary number of cells. Cells can contain virtually any Smalltalk-80 object, from simple numbers to charts, graphs, vectors, and matrices. Spreadsheets can be linked together to form powerful distributed spreadsheets. Entire personal databases can be kept in cells, allowing the user to both query and analyze them from within a spreadsheet.

The Analyst Outlines. The Analyst supports creation, editing, and manipulation of outlines. Ideas and concepts can be copied from one outline to another. Outlines can be used to create structured documents which can be printed and formatted in a variety of ways. Outlines can automatically eliminate items that are flagged as being sensitive to a particular audience.

Report Generator. Reports, documents, and memos can be generated by combining text, graphics, maps, and images in an editable WYSIWYG window, from information stored in any information center.

Communications. Powerful RS232C and Ethernet communications packages are included in The Analyst. RS232C windows can emulate intelligent text and graphics terminals. Graphics terminal emulators can capture command streams for later analysis. All terminal emulators are integrated with The Analyst's multi-window editing environment. Ethernet packages allow communication with all XNS printers and servers.

Specifications. The Analyst Workstation System adds 200 new classes to the Smalltalk-80 system, providing 6,500 new functions with about 2 million bytes of commented source text. An on-line User Guide provides instructions specific to particular tasks and a Demo Center provides examples of windows and tools. Concise on-line instructions, along with meaningful menus and graphics, allow users to make efficient use of the system.

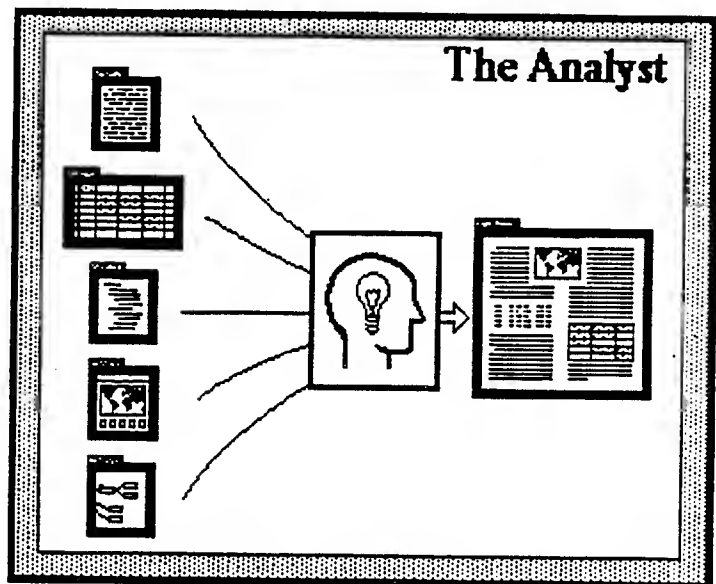
Applications. The Analyst is ideally suited as a personalized working environment for professional analysts. It can also be exploited as a foundation upon which sophisticated new interactive applications can be developed to enhance the Xerox Smalltalk-80 system.



ANALYST™

Product Description

June 1987



**Xerox Special Information Systems
Vista Laboratory
250 North Halstead Street
P.O. Box 5608
Pasadena, CA 91107-0608
(818) 351-2351**

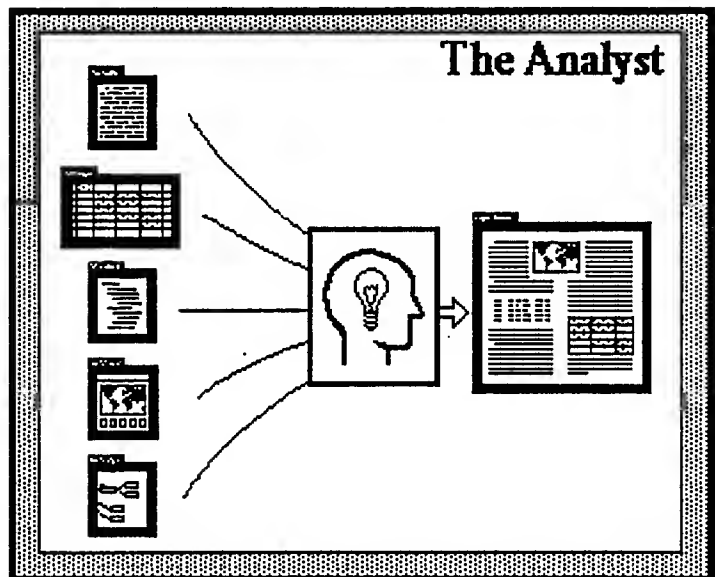


The Analyst

A Smalltalk – 80 Information Analysis Tool

Introduction

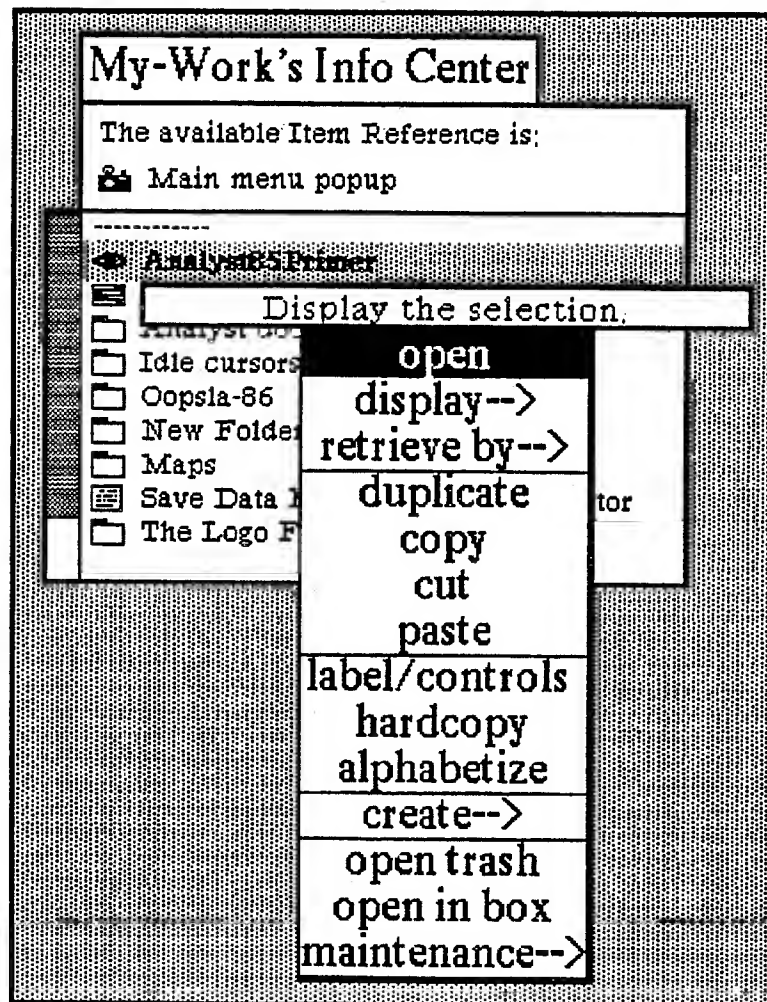
The Analyst workstation system is an integrated set of special application packages implemented in the Xerox Smalltalk–80 system. Professional analysts, programmers and casual users benefit from the flexible working environment that can be customized as needed. At the same time, The Analyst forms the foundation for the development of additional sophisticated integrated applications. The Analyst system was designed to meet the need for an intelligent, interactive, graphics–oriented front end to the real world of continually changing task requirements.



Window–based application packages currently integrated in The Analyst include the Information Center, Text Editing, Document Layout, Report Generation, Maps and Images, Business Graphics, Spreadsheets, Outlines, Personal Databases, Printing, Clocks, Calendars, On–line Atlas, Auto Books, Expert Systems, and Terminal Emulation. A complete and flexible system of security level designations is also included.

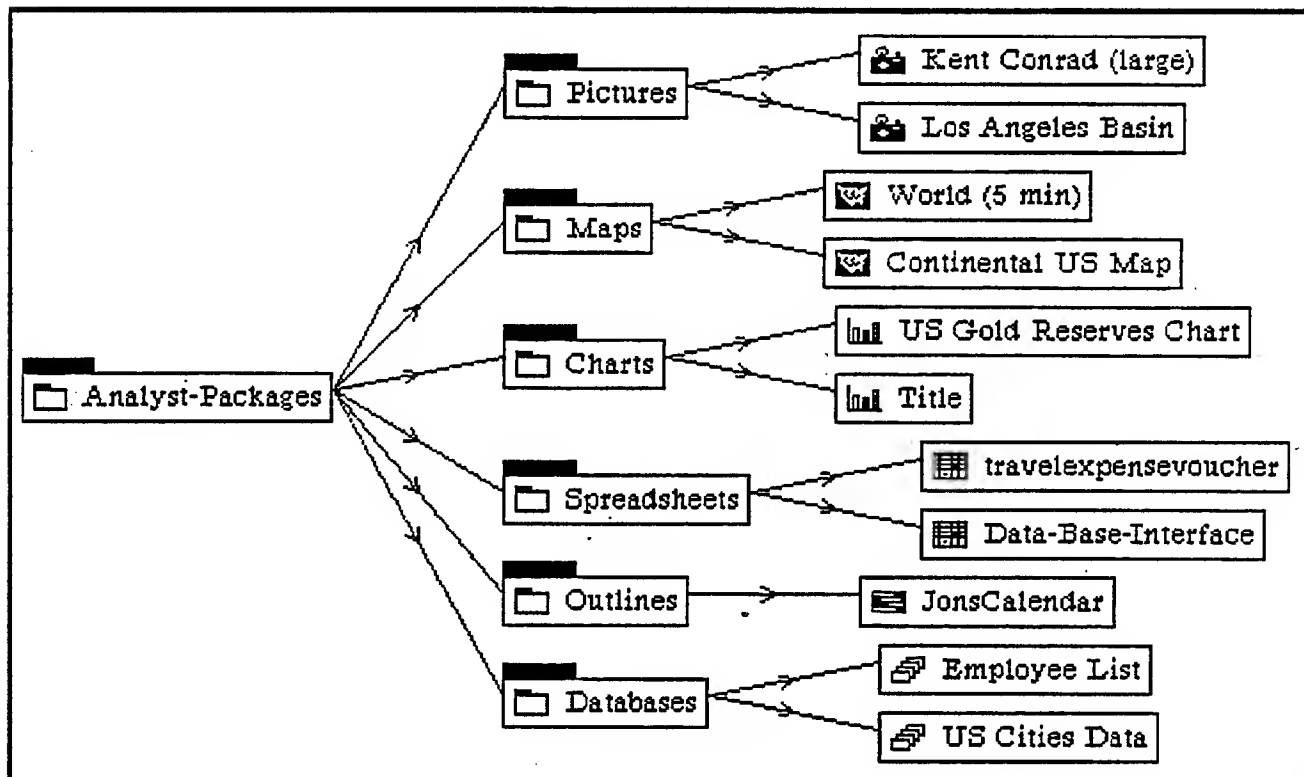
System Concepts

The Analyst system addresses the management of information and the production of finished reports based on that information. A primary goal of The Analyst development project was to create a system readily accessible to the average (particularly non-computer savvy) user, providing a personal, integrated, and extensible environment employing a uniform graphical interface. Uniformity of application interfaces allows the user direct access to each task without the additional chore of learning a multitude of different interfaces. At every step, the user is presented a list of alternate actions in pop-up menus and dialog boxes, eliminating the necessity of learning a command language. Every feature in the system has been designed with an eye toward making it easy for the user.



Data Organization

The Analyst organizes data in a method designed to be both intuitive and flexible. The system is easy and natural to use for anyone familiar with the operation of the standard office filing system, as its design and terminology are based on those very concepts. Just as the usual filing scheme in an office consists of a hierarchy of filing cabinets, drawers, and folders, The Analyst organizes large collections of data into information centers that are further organized into smaller collections called folders, which in turn contain items and other folders.

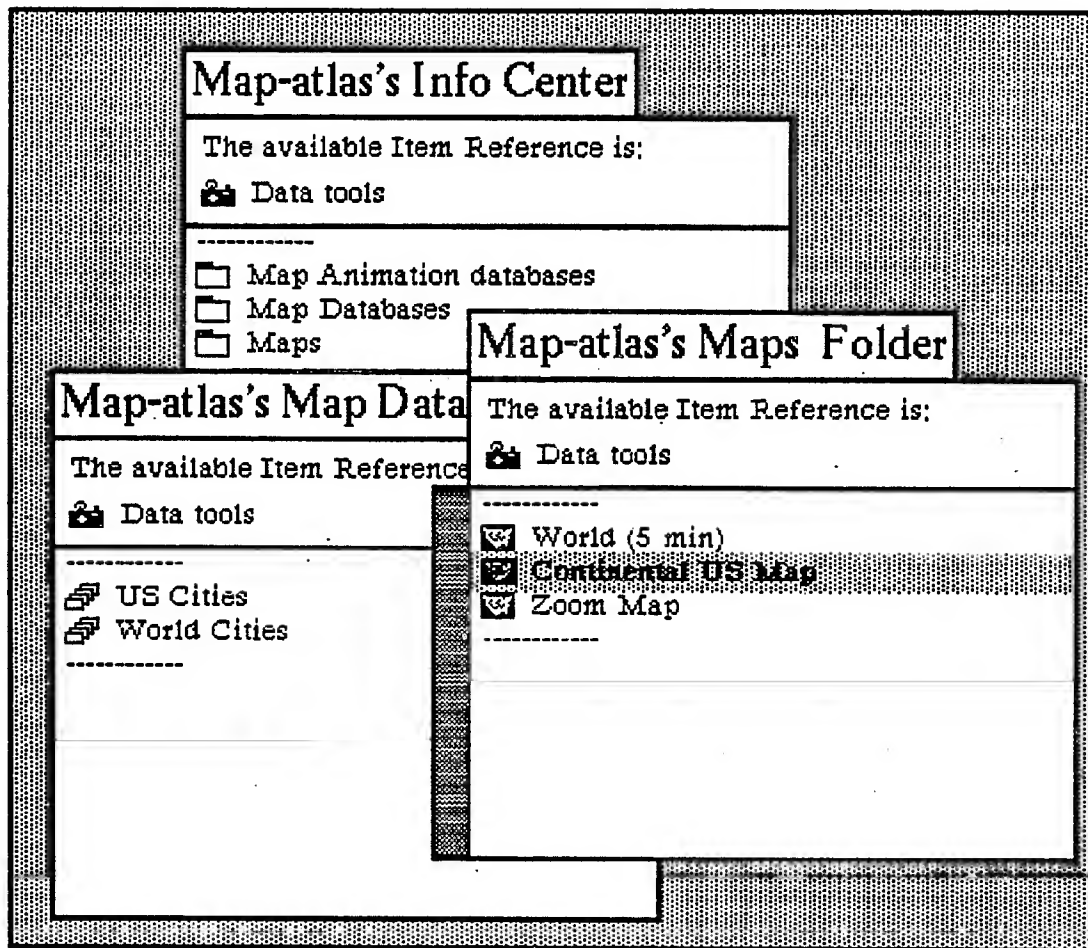


Application Packages

Application packages integrated in The Analyst system are window – based and employ a uniform user interface. Packages currently supported are the Information Center, Text Editing, Document Layout, Report Generation, Images, Maps, Business Graphics, Outlines, Spreadsheets, Personal Databases, On – line Atlas, Expert Systems, and text and graphic Terminal Emulation.

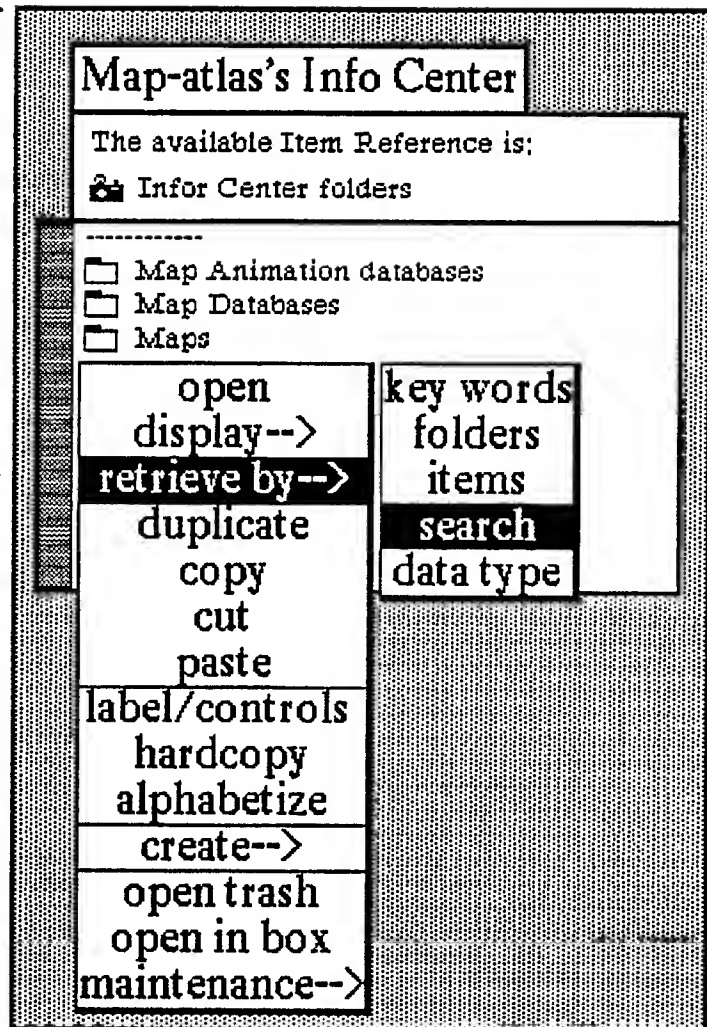
Information Center

The Information Center is the hub of The Analyst system. It is an *information management* device that places innumerable resources within easy reach of even the most inexperienced user. An Information Center consists of a user constructed hierarchy of folders and data items. With the tools available in an Information Center, the user can do everything from creating a one–line memo to generating a comprehensive document that includes sophisticated formatted text, spreadsheets, graphs, maps, and illustrations.



The Information Center is the ideal "gopher", complete with cross–references, item references, keywords, annotations, and other methods of finding and retrieving just the right folder or individual item the user might need. While the overall structure of an Information Center is represented as a hierarchy of folders, the user can add other relational connections of his own creation, i.e. source connections, note connections, or reference connections. He also has access to resources such as maps, charts, photographs, and any other relevant material he may have saved for future use. In addition, there are tools available to create charts, outlines, spreadsheets, databases, and maps.

Another special and personal feature of the Information Center is its flexibility. It is as individual as each user: available tools can be utilized according to an individual user's work habits; the user does not have to adjust to a rigid system. The user is provided with everything needed to organize and use information in whatever style best suits him/her. The user can retrieve, manipulate, and create items in a manner very close to old-fashioned, hands-on, pen and paper directness, while at the same time utilizing the speed, accuracy, flexibility, and power of the latest technology.



Text

The text editing windows in The Analyst allow the creation and editing of formatted text. The ability to quickly and easily create a document such as a memo, report, or summary is an integral part of The Analyst software.

All text entry and editing is done in the *text pane* of a window. Within the text, the user may choose a variety of fonts and styles; annotate passages; copy – cut – paste anything from single words to entire text sections, from any text pane on the screen; and even compute numbers. All these capabilities are available in any text pane of any window.

Document Layout

The Preview window is The Analyst system's document preparation and page layout tool. It allows the user to compose documents that contain both text and graphics. It is also used to perform certain editing functions that cannot be done in a regular text window, such as creating multiple column formats, justifying text, changing margin settings, varying line spacing, locating page breaks, and accurately setting tabs.



The Preview window allows text to flow around pictures. When the user places a picture (drawing, image, map, chart, graph, etc.) onto a page in the Preview window and composes that page, the text will position itself around or at the side(s) of the image. The text and graphics seen in the Preview window are exactly the way they will appear when printed (popularly known as *WYSIWYG*, or *what – you – see – is – what – you – get*). Thus, the user can be sure that his screen layouts of text and images will be accurate and realistic.

Images

The Image Editor allows the user to create bitmap illustrations for the enhancement of otherwise conventional text reports. These illustrations may be created from scratch, derived from digitally scanned images, or input from the Chart Editor (a business graphics package). The editing tool within the Image Editor allows application of iconic or textual annotations to the illustration, drawing attention to specific areas of interest on the presentation.

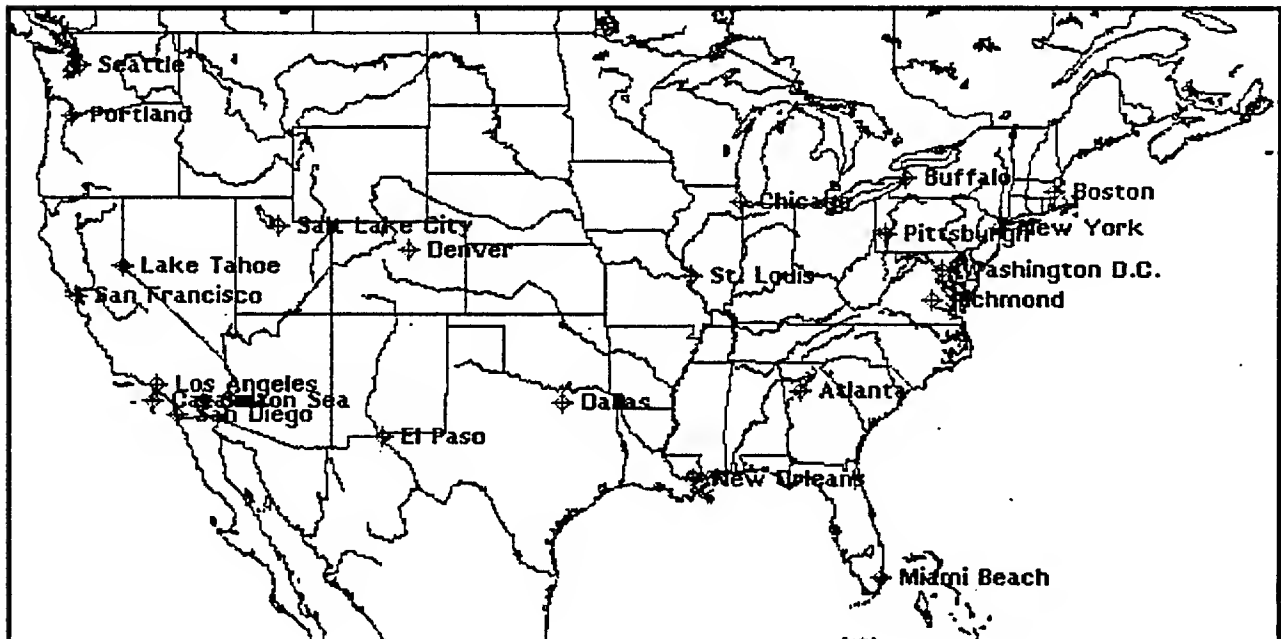
A composite picture may be created by a simple cut and paste of other pictures. The completed work may be filed away in an Information Center to be recalled when needed.

Mug Shots



Maps

The Map Editor provides the capability of displaying or creating bitmap images generated from a digital geographic database, which then can be edited and annotated. Maps are generated on demand from a map database that has been stored on the local disk or in a remote mass storage device, such as a file server. The Map Editor provides the capability to expand (zoom) areas within the displayed area and to annotate the map with data from other databases.

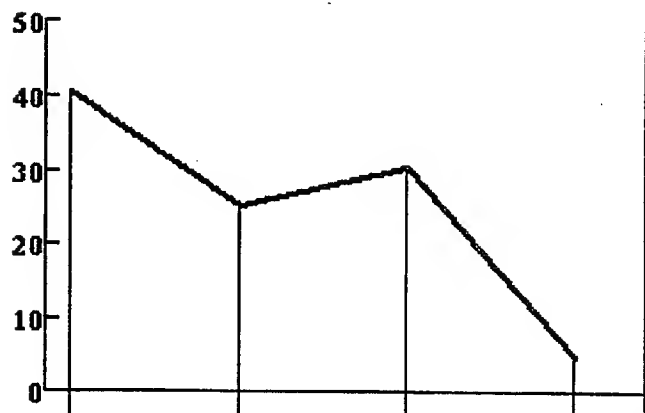
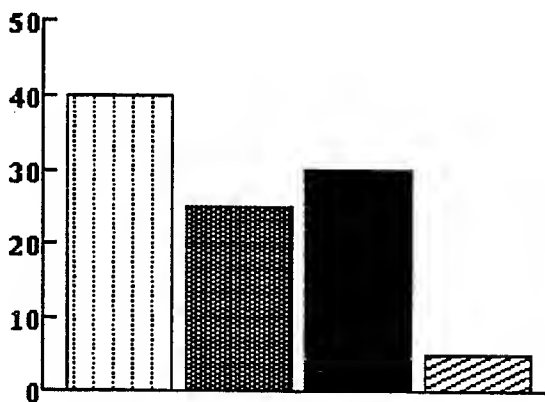
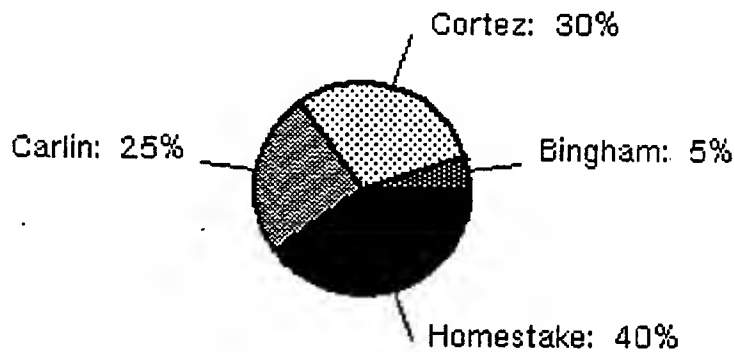


Map databases can be files of cities, harbors, depots, or anything else the user finds useful as annotations for maps. Such databases may be queried by pointing to any of the displayed points on the map; the full database record corresponding to the selected point is displayed for the user. Information Centers may be searched in the same manner by directing the query to the Information Center rather than to the database.

Business Graphics

The Chart Editor is a graphics tool produces different types of charts from user supplied or database data. The user has a choice of producing pie, bar, or line charts, clustered and stacked bar charts, x-y scatter, or linear fit plots. Data points for a chart may be derived from a database or specified interactively by the user. The chart may be quickly replotted in several different chart types so that the user can choose the best presentation of the data.

U.S. Gold Reserves



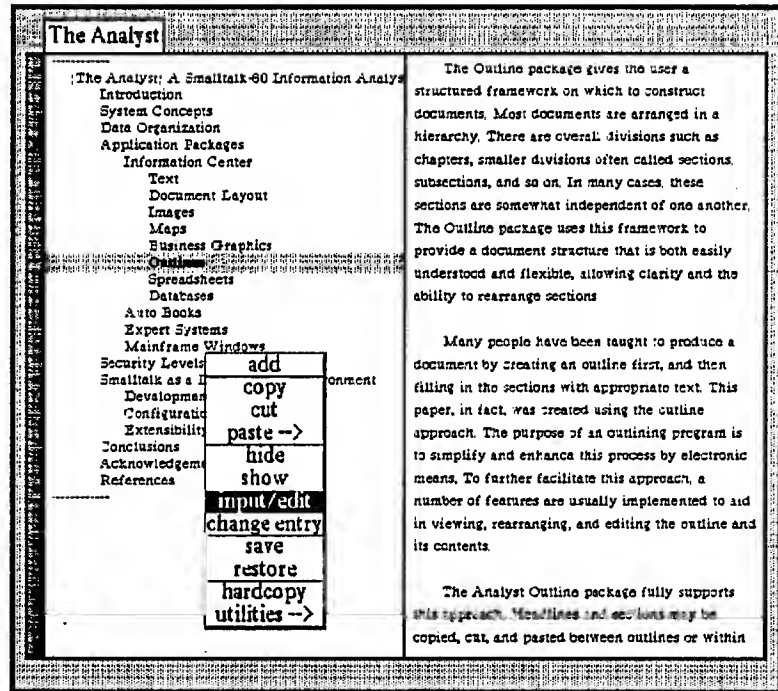
Outlines

The Outline package gives the user a structured framework on which to construct documents. Most documents are arranged in a hierarchy. There are overall divisions such as chapters, smaller divisions often called sections, subsections, and so on. In many cases, these sections are somewhat independent of one another. The Outline package uses this framework to provide a document structure that is both easily understood and flexible, allowing clarity and the ability to rearrange sections.

Many people have been taught to produce a document by creating an outline first, and then filling in the sections with appropriate text. This paper, in fact, was created using the outline approach. The purpose of an outlining program is to simplify and enhance this process by electronic means. To further facilitate this approach, a number of features are usually implemented to aid in viewing, rearranging, and editing the outline and its contents.

The Analyst Outline package fully supports this approach. Headlines and sections may be copied, cut, and pasted between outlines or within an outline. Sections can be hidden while not being worked on. Outlines can be concatenated together. Text can be edited within the outline window or in spawned windows. Inline computation of values is possible within the editor window, just as in the standard text window.

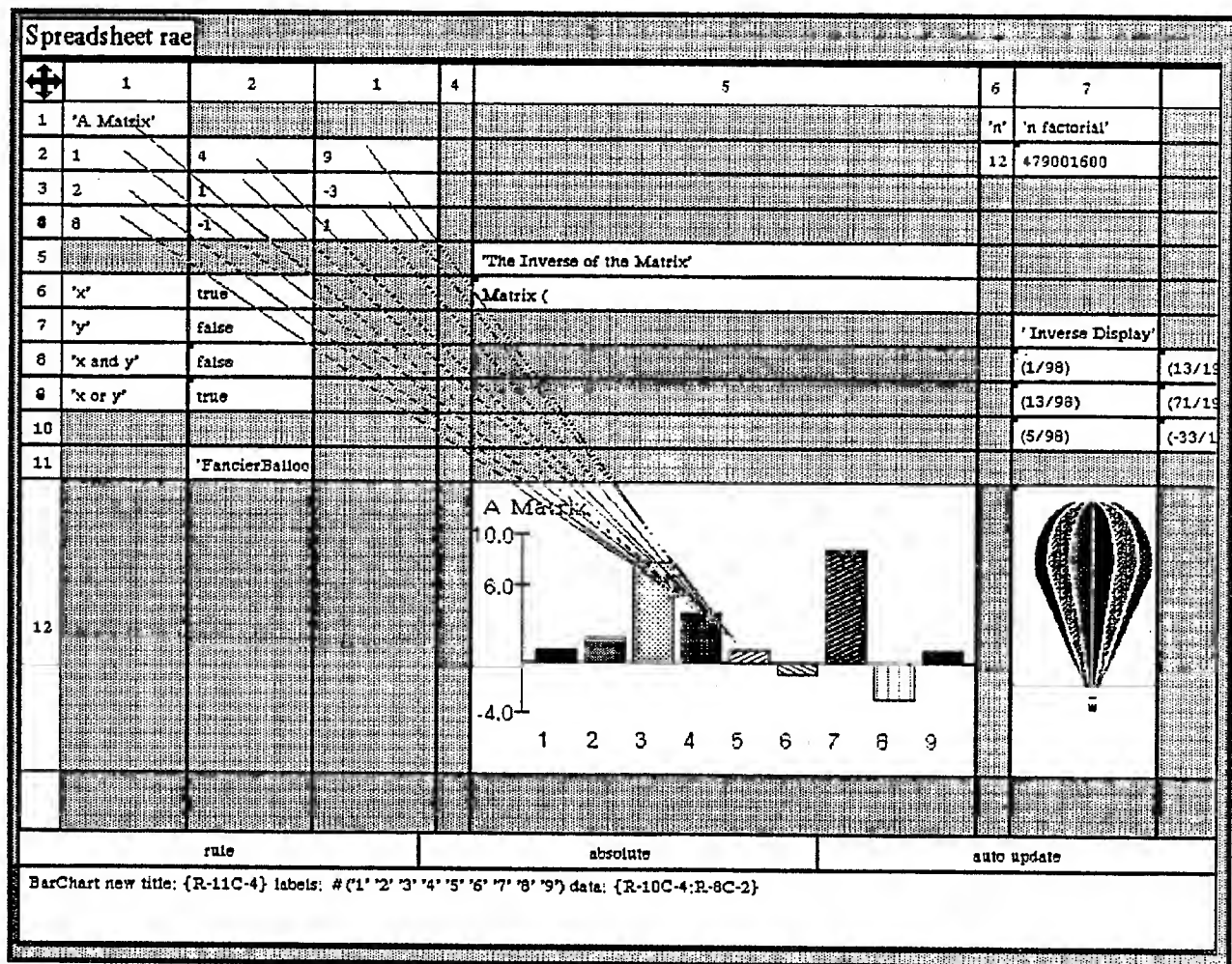
This package also supports some rather unusual features. First, as is fitting in any environment where data security is important, The Analyst allows each section of the outline to have a separate security level. These are of interest when hardcopy of the document is desired, since in many cases documents have specific requirements on maximum security level. When hardcopy is produced, the outline package automatically edits out sections too sensitive to be included, often resulting in a tremendous time saving for the user.



Spreadsheets

A Spreadsheet is a modeling device or tool that lets you explore "what-if" scenarios. It is arranged as a two-dimensional array of cells indexed by row and column. Cells contain values that can be computed dynamically from user-specified rules that may reference values from other cells. Spreadsheets in The Analyst can, in addition, be linked together to form powerful distributed spreadsheets.

Each cell of a Spreadsheet can hold any Smalltalk – 80 object. Images, databases, pop-up menus, files, and many other Smalltalk – 80 objects can be used. New functionality added to the Smalltalk – 80 system is automatically accessible by Spreadsheets without modification to the Spreadsheet application software.



Databases


The Analyst Database package is a powerful personal data management tool by which the user can rapidly review data, make many kinds of additions or changes to it, create new data items, and manipulate the data according to user – specific needs. Database information is integrated with other application packages via the Information Center, so that extracted data can be sent to a Chart Editor or accessed in a Spreadsheet. Cartographic information can be stored in a database and accessed by the Map Editor. Individual records may be independently assigned security levels.

The basic functions in the Database package are data entry, data manipulation, and data output. Data entry can start from a blank record whose fields are to be filled in from scratch by the user; or from an existing record that may be used as a template for entering the next one. A menu – driven query function assists the user in the creation of a syntactically correct query, eliminating the need for the user to learn the query language. This capability allows the user to concentrate on the question behind the query without worrying about syntax. Data output functions allow the user to sort a list of records identified by a query, and then produce a report that can be immediately hardcopied. Selected records may also be sent directly to the Chart Editor to produce line, bar, or pie charts.

| US Cities | | |
|----------------|---------------------------|-----------------------|
| FIELDS | HITS | () |
| Label | Boston | Label: Salt Lake City |
| Icon | Buffalo | Icon: J |
| lat | Chicago | lat: 40.75 |
| lon | New York | lon: 248.134 |
| key | Pittsburgh | key: SaltLakeCity |
| | Portland | |
| | Salt Lake City | |
| | Seattle | |
| | 8 hits | |
| | running from | |
| QUERIES | REPORTS | |
| lat > 40 | | |

Auto Books

Auto Books allow the user quick access to large reference documents. The example currently in use in The Analyst is a World Atlas. This tool provides a graphical interface (a world map) to quickly select the area of interest in the world. A list of accessible countries allows the user to select the desired country. The information for each country is displayed in outline format facilitating rapid browsing of the contents of the Atlas.

| World Atlas | |
|--|--|
|  | |
| <div>Brunei</div> | |
| <div>Land</div> <div>Water</div> <div>People</div> <div>Government</div> <div>Economy</div> <div>Communications</div> <div>Defense Forces</div> | <div>Population</div> <div>Nationality</div> <div>Ethnic divisions</div> <div>Religion</div> <div>Language</div> <div>Literacy</div> <div>Labor force</div> <div>Organized labor</div> |
| <p>Population: 209,000 (July 1983), average annual growth rate 4.0%</p> <p>Nationality: noun-Bruneian(s); adjective-Bruneian</p> <p>Ethnic divisions: 65% Malay, 24% Chinese, 11% other</p> <p>Religion: 60% Muslim (Islam official religion); 8% Christian; 32% other (Buddhist and animist)</p> <p>Language: Malay and English official, Chinese</p> <p>Literacy: 45%</p> <p>Labor force: 32,155; 33.8% trade, transport, and services; 32.8% industry, manufacturing, and construction; 30.5% agriculture; 2.9% other</p> <p>Organized labor: 8.4% of labor force</p> | |

Expert Systems

HUMBLE, an expert system shell written in the Smalltalk—80 system, is another package available to add to The Analyst. Used in an integrated manner with the other packages in the system, it makes expert systems available to the working analyst in the same environment as his/her other tools.

Mainframe Windows

Within The Analyst both textual and graphical RS—232 terminal emulation are provided.

The Textual Terminal Emulation window provides a terminal interface to a host computer. This window provides access to whatever resources are present on the user's host mainframe. This includes access to whatever mail system is available. The level of integration of tools within The Analyst allows the user to capture and automatically file away in his Information Centers any mainframe terminal exchange.

The Graphics Terminal Emulation window provides a graphics terminal interface to a host computer. This makes all of the mainframe's graphical tools accessible to the user. In addition to capturing and saving mainframe drawn graphics as bitmaps, the graphic vectors can be captured and saved in Map format for later enhancement by the user with the Map Editor.

Security Levels

The Analyst system's Data Security facility helps insure that any organization's data remains where it belongs. Since all data windows always display the current security level of any data being reviewed, accidental dissemination of private information becomes impossible.

Items that comprise a typical Information Center, such as reports, folders, illustrations, etc., may be given a security level either when they are first created or at any time after that. In addition, the security level can be upgraded, downgraded, or removed. The Information Center folders in which private files are stored will always reflect the highest security level represented by their contents. Even more detailed information control is provided for Outlines and Databases where individual entries may be assigned different security levels.

| Change Classification | | | | | |
|-----------------------|--------|---------|-------|-------|------|
| accept | cancel | bailOut | | | |
| Classification | | Int | XPers | XPriv | XReg |

The Security scheme used by The Analyst is externally specified and may be altered to meet new requirements without modification to system software. Changes to the Security scheme in use will be noted by the system and existing data will be automatically updated to use the new scheme. Security levels are tracked as data is copied from one window to another as a standard feature of The Analyst. Data windows reflect the highest security level for the information they display.

Extensibility

New applications can be readily inserted into the framework of The Analyst. A fully defined and documented programmer's interface is designed to aid other implementers in extending and customizing The Analyst's capabilities for suit specific requirements. The programming tools available in the Smalltalk – 80 environment provide the programmer complete access to all of the source code in the system, making available a wealth of past programming experience. The interface to the application packages in The Analyst are available to be browsed, exploited, and emulated. A programmer can combine existing features, from the Smalltalk – 80 system and from The Analyst application packages, into new applications.

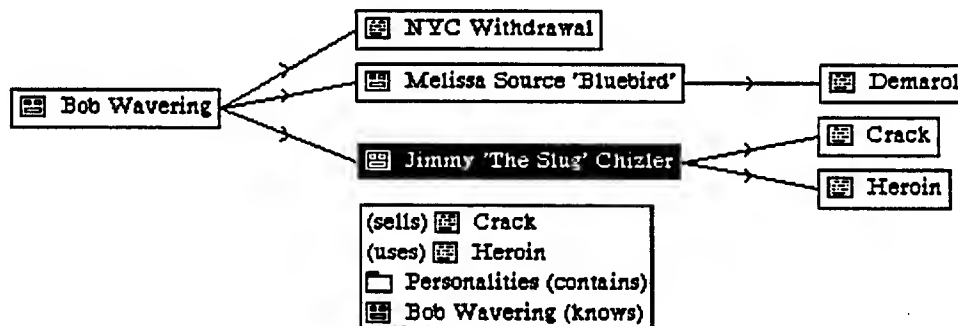
Smalltalk as a Development Environment

The personal integrated, interactive programming environment provided in the Smalltalk – 80 system provides ready access to existing system facilities, including source code, making a wealth of past programming experience available to the programmer. The powerful interactive programming tools allow the programmer to rapidly make complex system changes, while being completely aware of the affect these changes have on the total system.

An Introduction to The Assistant

So what is this Assistant package you've been told about? To understand what it does, we need to fill in a little background information. First, you need to have an idea what The Analyst and Information Centers are capable of doing.

The Analyst, a Xerox information analysis environment, holds a wide array of tools which can be used to store, analyze, and retrieve information. One of the key features of The Analyst are the information management tools called Information Centers. The Analyst stores chunks of data, called items, in a network of links which specify how the items are related to one another. The networks are called Information Centers. An example might be a network of personalities, contacts, and habits of persons involved in drug trafficking. Here's a simple example, a drawing of the relationships between a small set of items, taken from an actual Analyst screen display:



In the example, we see a very simple network. The drawing focusses on Jimmy 'The Slug' Chizler, a small time hood. A number of important facts are contained in this drawing. For instance, Jimmy knows a fellow named Bob Wavering, who has access to a large withdrawal recently made in New York City. Jimmy is also known to sell Crack, a dangerous but popular drug. Obviously, this combination of facts leads to a possible inference, that Jimmy could conceivably sell these drugs to Bob Wavering.

This sort of deduction is made easy and obvious by the Information Center tools in The Analyst. But imagine you are trying to assess the impact of new information on a large collection of information, perhaps about hundreds of people, dozens of drugs and bank transactions. How could anyone keep track of all those possible relationships?

The answer is The Assistant, a package which allows Information Centers to look for patterns the user defines, and make new links based on those patterns. Imagine you could write a rule which went something like this:

A buyer is someone who has available cash and knows a contact.

A contact is either a pusher or knows one or is a user.

A pusher is someone who sells drugs.

Any buyer could buy drugs.

If you applied this to the original example, for instance, you would infer that Bob Wavering could buy drugs. You could also apply this general rule to much larger sets of items, looking for similar patterns.

This is precisely what The Assistant does.

It takes general rules about patterns of links, like the rule above, and makes new links based on the old patterns. While it works, it notifies the user about all of the links it is making, to point out to him possible areas of interest.

The possible applications include any sort of work where complex relationships between items must be tracked. Law enforcement applications are an obvious choice, but these are by no means the only applications The Assistant can handle. Organizing tools, legal argument analysis, and a whole range of other applications are all possible. Anywhere where patterns of relationship among large collections of elements must be analyzed, The Assistant provides the right tool to accomplish the task quickly and effectively.

ASP-The Analytic Spreadsheet Package



An advanced object-oriented spreadsheet package for the Smalltalk-80 system

ASP™ is an analytic spreadsheet package that provides access to the full power of the Smalltalk-80™ programming environment. Developed by Xerox Special Information Systems (XSIS) as part of The Analyst™ Workstation System, ASP is now available as a separate package for the Smalltalk-80 environment.

Unlike other spreadsheet packages, ASP is designed for the analysis of more than just numbers and labels. Vectors, points, collections of data, text, charts, files, and images are just a few types of objects that ASP can manipulate and display.

While ASP provides a large array of predefined functions, it is also extensible. By adding new methods to the Smalltalk-80 environment, ASP can be instantly expanded to match user needs, without requiring extensive knowledge of either ASP or the Smalltalk-80 system.

Graphical User Interface

ASP spreadsheets can be created interactively with an arbitrary number of cells. A graphical, mouse-based user interface is provided for selecting cells, rows, columns, or rectangular sections; for entering values and rules into cells; for adjusting the width and height of rows and columns; for scrolling to arbitrary rectangular regions; and for performing many other spreadsheet functions.

Flexible Data Types and Formulas

Virtually any type of Smalltalk-80 object can be displayed and manipulated in an ASP cell. Most Smalltalk-80 language constructs are available in ASP formulas. This includes the use of temporary variables for storage of interim values. Spreadsheets have been developed that interface to databases, perform image processing, conjugate regular verbs,

and many other advanced functions. Truly unprecedented power is available to those whose analysis tasks reach beyond simple numeric processing into the realms of symbols and data structures.

Special Data Types

Several special types of data are included with ASP to allow the manipulation of matrix objects and business graphics (pie, bar, and line charts) within cells. Simple accessing protocols make it easy to deal with these complex objects.

Interlinking

Spreadsheets can be linked together in a hierarchical fashion to form powerful distributed spreadsheets. ASP can access information from any spreadsheet that is loaded in main memory or stored on a local disk.

Minimal Recalculation Technology

ASP automatically calculates the minimal number of cells to update when a change is made. ASP also determines the sequence of updates to cells to assure correct answers.

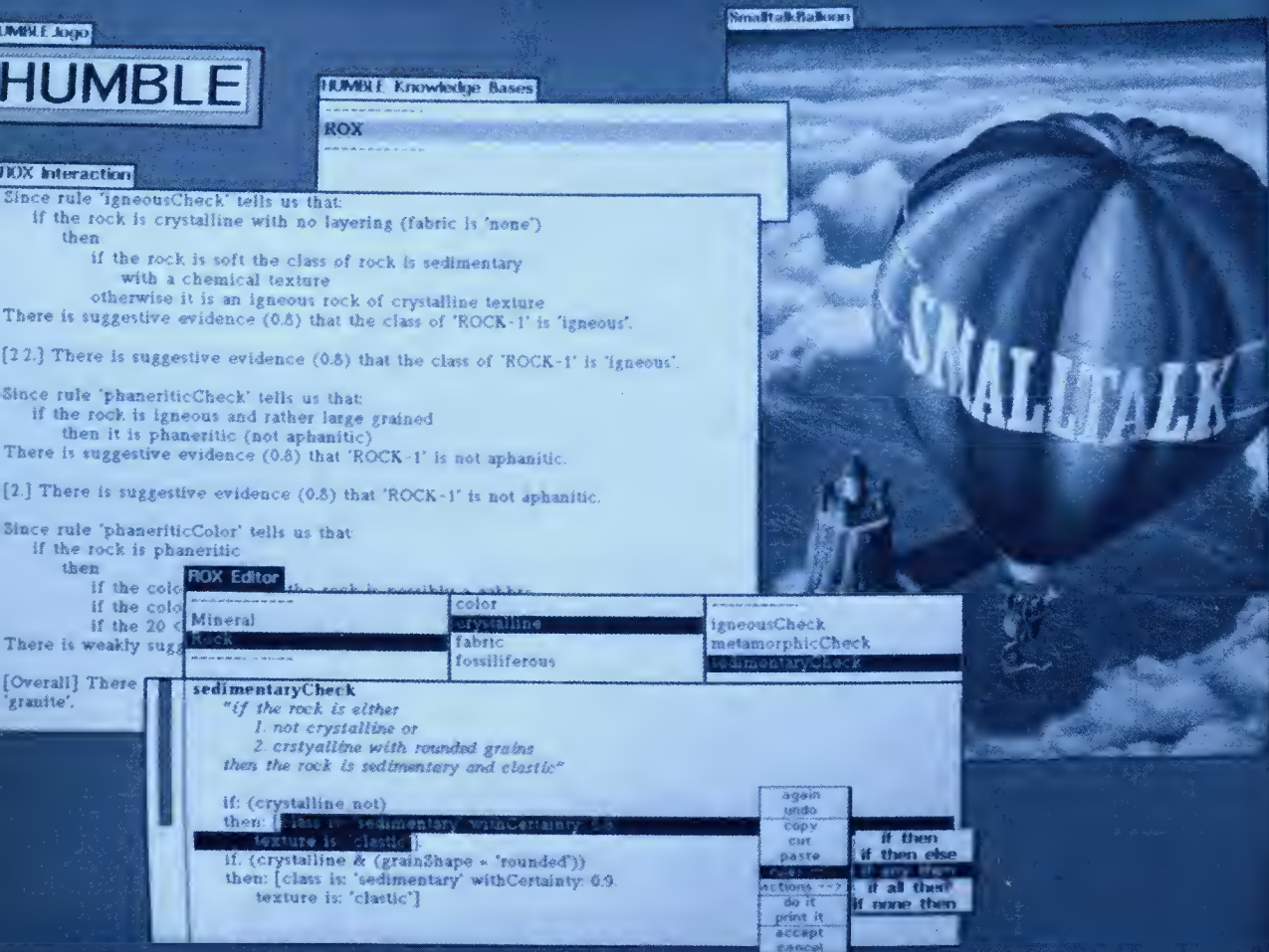
Source Code

Complete source code for ASP is included with the package, allowing local programming support and extension of the package if needed.

Requirements

ASP is designed to run in Smalltalk-80 systems that are based on the License Version 2 Virtual Image. A minimum of 500 Kbytes of memory must be available after the Smalltalk-80 image is loaded.





An advanced Smalltalk-80 based expert system tool

HUMBLE™ is an advanced expert system building tool which runs entirely within the Smalltalk-80™ environment. Users add rules and data definitions to create expert systems for specific problems. Developed by Xerox Special Information Systems (XSIS), HUMBLE meets the needs of many diverse applications because it is easily modified and extended by the user.

Complete source code is provided with the package. Input and output can be redirected to a user generated interface package, if desired. The certainty model which HUMBLE uses to make decisions can be altered.

Forward and Backward Chaining

Both forward and backward chaining are possible within a single HUMBLE knowledge base. Backward chaining is automatic during execution, while forward chaining can be specified at any point during rule execution.

Multiple Knowledge Bases

HUMBLE supports the existence of several knowledge bases simultaneously. A complete programmer's interface allows any Smalltalk-80 application to interface with HUMBLE knowledge bases.

Multiple Execution Contexts

HUMBLE supports the concept of multiple execution contexts, allowing the same rules to be applied to several similar objects within a knowledge base.

Understandable Rule Language

The rule language in HUMBLE is exceptionally easy to read and write. It also contains an *escape* to standard Smalltalk-80 code, should an application require functions not built into the rule language.

Advanced Editor/Browser

The knowledge base editor provided with HUMBLE resembles the Smalltalk-80 code Browser. It is mouse driven, and includes automatic cross referencing features. It provides all of the organizational advantages of rule sets, without the restrictions.

Redirectable Input and Output

Output from a HUMBLE knowledge base can be directed to any Smalltalk-80 Stream object. Input can be obtained from standard or user implemented objects. Trace and debugging facilities, also redirectable, are provided.

Reasoning under Uncertainty

HUMBLE uses the standard MYCIN certainty model. However, for users who require alternate approaches, the certainty model is designed to be easily altered to suit the needs of particular applications. A simple subclass which responds to eight messages is all that is required to entirely replace the certainty model. In fact, different knowledge bases may have entirely separate certainty models.

Explanation

HUMBLE knowledge bases explain their reasoning in English. A backward chaining mechanism in the explanation facility gives complete, concise explanations. Alternatives can be examined and explained.

Source Code

Complete source code for the HUMBLE shell and its supporting windows is included with the package. Modifications and additions are encouraged, particularly in the areas designed to be modular: the certainty model and input/output.

High Performance

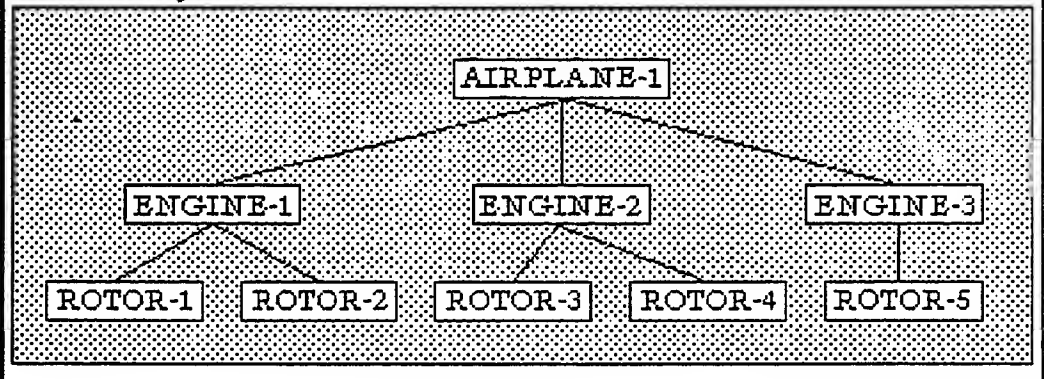
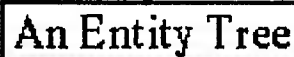
HUMBLE's processing speed is very quick: 125 rules per second on a Xerox 1132 processor. Further, execution rate does not degrade when the size of the rule set increases.

Requirements

HUMBLE is designed to run in Smalltalk-80 systems that are based on any License Version virtual image. A minimum of 200 Kbytes of memory must be available after the Smalltalk-80 image is loaded.



June 1987



HUMBLE: A Smalltalk – 80 Expert System Shell

HUMBLE is an expert system shell written in the Smalltalk–80 programming environment. It provides a number of advanced tools to those wishing to do expert system development in Smalltalk. HUMBLE will run in any Smalltalk Licensed Version, including those available on Xerox. Tektronix, Apple, IBM machines. Knowledge bases are source code compatible on any of the above machines.

Features

HUMBLE contains a wide array of desirable features. It is a true expert system tool, not merely a simple decision tree or table. Considerable effort has been expended to assure ease of use and understanding.

In technical jargon, HUMBLE is a goal–directed multiple–context expert system shell, with reasoning under uncertainty.

What that means is that HUMBLE can:

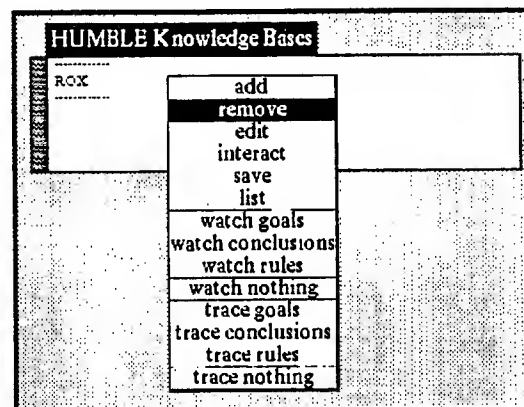
1. Interpret user supplied rules to make conclusions.
2. Fire rules on its own initiative, in response to questions asked of it.
3. Apply the same rules to a number of similar but independent entities.
4. Handle uncertain data, in a predictable and reasonable manner.

Each of these points, as well as the user interface, is discussed more fully in the following sections.

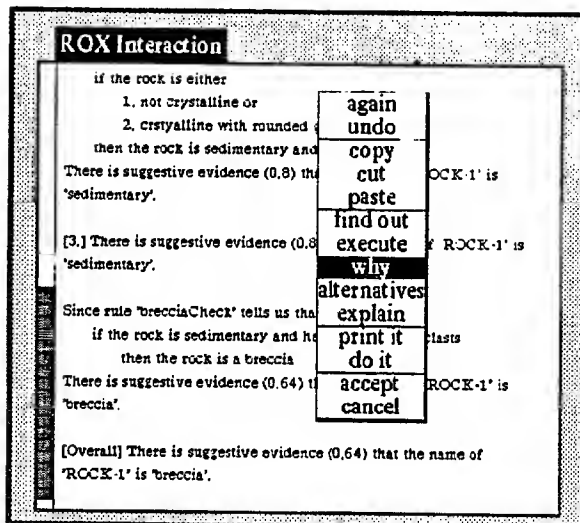
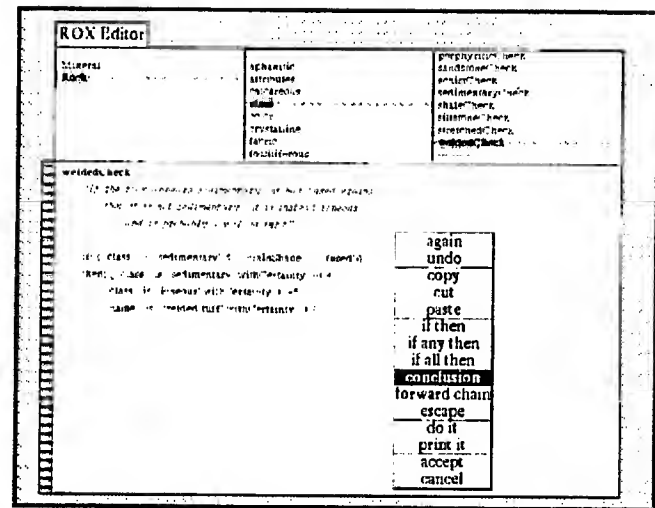
Interface

The basic HUMBLE system contains three standard windows which form the interface between the user and the knowledge base. All three windows use the standard Smalltalk Model – View – Controller window scheme, to assure wide compatibility with existing Smalltalk images.

The system level interface to HUMBLE is a window called the *Manager*. The Manager provides the user with a list of all knowledge bases presently loaded into Smalltalk. By making selections and giving commands in the Manager, the user can load and unload, edit, interact with, and control the outputs from any of his knowledge bases.



The second window, the *Editor*, is a browser for entering rules and entity definitions. This browser provides easy and structured access to the expert system being built. The user can browse and edit any part of the static knowledge of the system from this single window. It is completely mouse driven, and exceptionally easy to use. The browser takes care of organizing the knowledge base, assisting with the generation and maintenance of the rules, and building the knowledge structure. Outwardly, this window resembles a simplified Smalltalk code browser.



The dynamic knowledge, or temporary information, is accessed through a consultation window, called the *Listener*. This window provides the user with an interactive transcript which includes mouse driven explanation facilities. In this window the user gives the system goals and data and receives conclusions and explanation.

Inferencing Method

HUMBLE uses goal directed reasoning as its main inference tool. In other words, when the system is given a goal, it will use the information implied in its rules to decide how to satisfy it.

The main method by which HUMBLE attempts to satisfy its goals is through the use of rules. Each rule is a specification of some conclusion that can be drawn if certain conditions are met. A simple rule might be something like 'If the animal barks, is a mammal, and is named 'Fido' then the animal is a dog'. HUMBLE rules are more precise, but the idea remains the same.

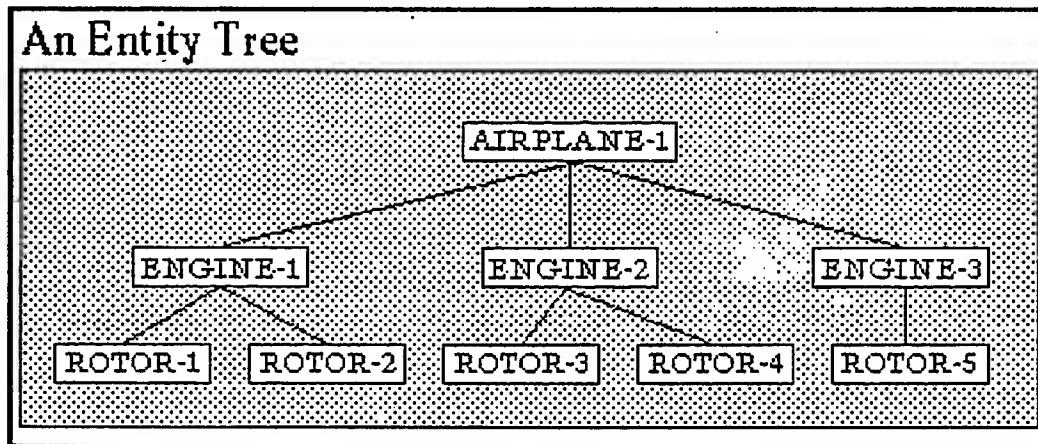
HUMBLE uses its rules to find the answers to questions it is asked. Given a goal, it will attempt to satisfy the conditions of some rule that makes a conclusion about the goal. In the example above, if the system is asked to find out what type of animal is being considered, it would notice that if the proper conditions are met it could say that the animal is a dog. Therefore, it would try to find out if the animal barks, whether it is a mammal, and what its name is. Each of these becomes a new goal, which might require that more rules be fired. Eventually, the system would get to a stage where it would ask the user for information, which would then be used to make the appropriate conclusions. This goal directed approach is also commonly called backward chaining.

HUMBLE is also capable of forward chaining. Essentially, any HUMBLE rule may cause another rule to be executed as part of its action clause. This adds both expressiveness and flexibility to the basic system. In cases where the programmer may wish the expert system he is building to explore an indirectly related matter, he may use forward chaining to give the inference engine new goals which might not otherwise have been considered.

The backward chaining approach has the advantage of being simpler for a non-programmer to use. All the user need do is specify rules and let the system decide when and how to apply those rules.

Context Switching

The HUMBLE shell can handle complex problems through the use of entity trees. In the diagram, for example, a knowledge base about an airplane might decompose the information about it into several similar parts, each of which should have the same rules applied independently to it. In any case where a complex object can be decomposed into simpler parts, but the number of parts is variable, multiple contexts provide a practical method of dealing with the individual parts. Obviously, if problems of any complexity are to be approached, the ability to maintain multiple contexts is vital.



Reasoning Under Uncertainty

Reasoning under uncertainty is an important capability in any expert system. Without it, any problem to be attacked must be susceptible to extremely clearcut solutions, and information must be exact. In the real world, of course, this is very seldom the case. This need to reason about uncertain events has spawned a host of techniques for representing them and making inferences with them.

HUMBLE uses the same model for certainty used by the MYCIN system. It maintains a number indicating the system's degree of belief or disbelief in a particular hypothesis. When several chains of logic point to a similar conclusion, they will reinforce one another. Similarly, if there is negative evidence, the system will weaken the belief in that hypothesis accordingly.

The system is also designed to allow a programmer to rapidly and easily change the uncertainty model to something different, perhaps a Bayesian or similar uncertainty scheme. A small set of localized changes are all that is required to effect a complete overhaul of certainty factors in HUMBLE. This allows for experimentation in the development of a given expert system, to find exactly which uncertainty scheme best suits the task at hand.

Explanation

HUMBLE provides a number of facilities which make it easy to receive explanations and examine alternatives generated by a consultation. The listener window supports a complete backward chaining explanation facility, which gives complete explanations of any fact HUMBLE knows or has inferred. This facility is mouse based, so the user can simply select the fact he is interested in (or type a description of it) and get a full explanation.

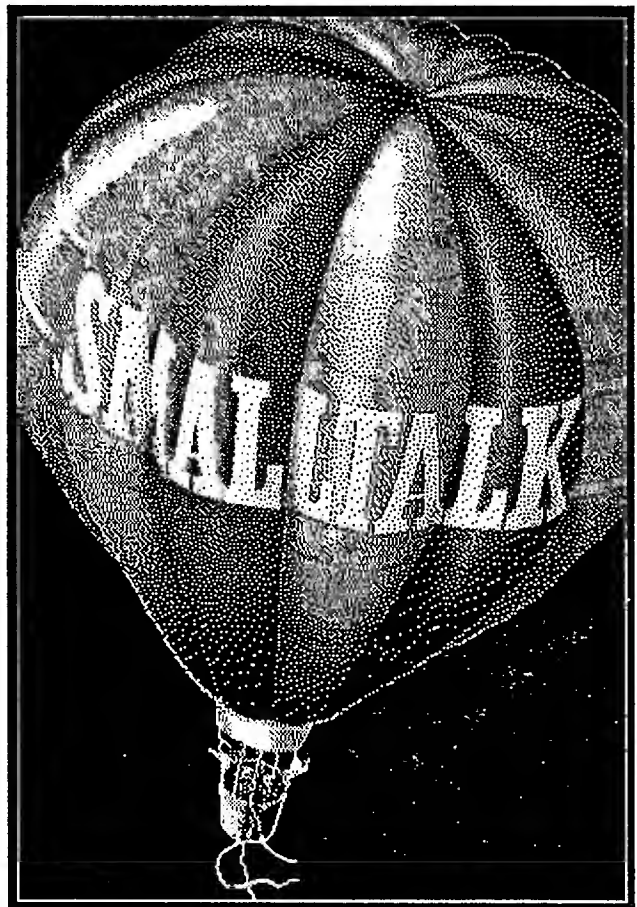
HUMBLE also supports examination of the alternatives to any given conclusion. Since each parameter in a HUMBLE entity can support many differing conclusions independently, it is often valuable to be able to examine the alternate conclusions HUMBLE has examined. This feature allows HUMBLE to be used not only as an expert system but also as a training aid.

The listener also supports complete examination facilities, so that the user can quickly scan the entire contents of the fact base HUMBLE generates. This makes it particularly convenient to examine the facts and alternatives and then ask for the reasons behind them.

Integration with Smalltalk

HUMBLE includes a programmers interface to allow it to integrate easily with Smalltalk-80 applications. Among the features of the programmers interface are:

1. A modular inquiry interface. This feature allows the programmer to alter the method by which HUMBLE makes inquiries of the user. If needed, the programmer can actually intercept questions and satisfy them under program control by reading databases, other Smalltalk objects, etc.



2. Interfaces which allow any of the following activities from any Smalltalk object:

- initialization of knowledge bases under program control
- examination of the fact base
- execution of rules from other objects

(very useful for integrating HUMBLE as the inference engine of a frame – based expert system)

- program driven explanation
- active values on HUMBLE parameters

(Particularly useful for graphic based interfaces)

- many other functions

3. Modular certainty models. The programmer can alter the certainty model used by HUMBLE to meet the needs of his particular knowledge domain.

HUMBLE rules can also contain directly imbedded Smalltalk–80 code. This code can take any action available to Smalltalk as a side effect of the evaluation of any rule.

Example Rules

A number of example rules follow, with some explanation of what should be going on when the rule is fired. HUMBLE rules make inferences about *entities*. These entities are described by their *parameters*. Whenever a parameter is referred to in a HUMBLE rule, it appears as a string surrounded by the { and } characters.

Typical Rules

Here are a few typical rules:

bloodPressureCheck

*"if the patient's blood pressure is high (above 120/80)
then his condition is probably critical"*
if: ({bloodPressure} > (120/180))
then: [{condition} is: 'critical' withCertainty: 0.4].

In this rule, the premise checks the parameter bloodPressure against the literal (120/80). if bloodPressure is greater, then conclude that parameter condition is now 'critical', with the rather low certainty of 0.4.

soilAcidity

"litmus > 50% blue indicates high soil acidity and poor lime content"
if: ({acidityCutoff} <= {litmusColor})
then: [{soilAcidity} is: 'high'.
 {limeContent} is: 'poor' withCertainty: 0.8]

```
else: [{soilAcidity} is: 'acceptable'.
      {limeContent} is: 'acceptable' withCertainty: 0.8].
```

This rule checks the color of litmus paper (parameter litmusColor) against the parameter acidityCutoff. If the test indicated high acidity, the parameter soilAcidity is set as well as the parameter limeContent. Note that this rule uses an else clause.

Forward Chaining Rules

In some cases, it is desirable to create rules which immediately fire other rules in a certain order. HUMBLE allows this by the creation of a *forward chain specification*.

bloodPressureCheck

```
"if the patient's blood pressure is high (above 120/80)
then his condition is probably critical"
if: ({bloodPressure} > (120/180))
then: [{condition} is: 'critical' withCertainty: 0.4.
      {@checkSodiumLevel}.
      {@checkObesity}].
```

This rule is similar to the example given in the previous section, except that it also specifies that the rules named checkSodiumLevel and checkObesity are to be fired whenever the condition is met.

Context Switching Rules

Certain rules switch the execution context of the system as they operate. These rules are searching rules, which make conclusions about any sub—entity which meets a criteria. An example:

olivineCheck

```
"if this rock contains olivine
then it is very likely a gabbro,
    it is unlikely to be a granite,
    and it is unlikely to be a diorite"
ifAnyOf: Mineral
have: [{mineralName} = 'olivine']
then: [{name} is: 'gabbro' withCertainty: 0.8.
      {name} is: 'diorite' withCertainty: -0.5.
      {name} is: 'granite' withCertainty: -0.5].
```

This rule checks whether olivine is present among a rock's minerals. If any of the sub—entities of type Mineral have parameter mineralName set to 'olivine', then the system makes conclusions about what sort of rock this one is likely to be. During execution, the context is switched to execute in each Mineral entity, both for the premise and the conclusions. Note the negative certainty in one conclusion, indicating that

the system believes that the rock is not diorite or gabbro.

Nested Rules

In some cases, for efficiency's sake, it is desirable to nest rules. HUMBLE allows this sort of rule and will take the necessary steps to see that certainty information is properly maintained for conclusions made by the nested rules. Here is an example:

siltstoneCheck

*"if the rock is sedimentary, small grained, and gritty to the tongue
then it is probably a siltstone"*

if: ({class} = 'sedimentary' & ({grainSize} <= 0.1))

then: [

 if: {gritty}

 then: [{name} is: 'siltstone' withCertainty: 0.8]

]

If more than one if—then is placed as part of an action block, then the result is an implied forward chain, since the nested rules will be executed in the sequence they appear.

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